

What is claimed is:

1    **1.** An angle sensor, comprising:

2           a reduction mechanism that reduces a rotation transmitted  
3    from a rotation axis;

4           a variable inductance mechanism that changes an inductance  
5    according to a rotation angle of a reduced axis of said reduction  
6    mechanism;

7           a detection coil that detects the change of inductance; and  
8           a circuit that detects the angle of said rotation axis from  
9    the output of said detection coil.

1    **2.** The angle sensor according to claim 1, wherein:

2           the change of inductance in said variable inductance  
3    mechanism is maximum near a rotation angle of zero in the reduced  
4    axis.

1    **3.** The angle sensor according to claim 1, wherein:

2           said reduction mechanism is a planetary gear unit including  
3    a sun gear, a planet gear and a ring gear.

1    **4.** The angle sensor according to claim 1, wherein:

2           said reduction mechanism has a reduction ratio of 1/4 to 1/10.

1    **5.** An angle sensor, comprising:

2           a rotation axis;

3           a magnetic body that rotates according to the rotation of said  
4    rotation axis;

5 a coil that generates a flux in a magnetic path including said  
6 magnetic body;

7 a magnetic sensing element that detects the flux which changes  
8 according to the rotation of said rotation axis; and

9 a detection circuit that detects the rotation angle of said  
10 rotation axis by using the output of said magnetic sensing element  
11 according to the change of flux.

1 6. An angle sensor, comprising:

2 a rotation axis;

3 a magnetic body that includes a tooth portion and rotates  
4 according to the rotation of said rotation axis;

5 a coil that generates a flux in a magnetic path including said  
6 magnetic body;

7 a plurality of magnetic sensing elements that detect a change  
8 in flux according to the rotation of said rotation axis in said  
9 magnetic path and output alternating signals with different phases  
10 from each other; and

11 a detection circuit that detects the rotation angle of said  
12 rotation axis by using the alternating signals;

13 wherein said tooth portion of said magnetic body is capable  
14 of moving relatively to said magnetic sensing elements and rotates  
15 according to said rotation axis.

1 7. The angle sensor according to claim 6, wherein:

2 said magnetic sensing elements each have a length of  
3 approximately half the width of protrusion or groove of said tooth  
4 portion, and

5        said detection circuit is a bridge circuit that uses at least  
6        two of said magnetic sensing elements and output alternating signals  
7        with different phases from each other.

1        **8.** An angle sensor, comprising:

2                first and second rotation axes disposed on the same axis;

3                a first magnetic body that rotates according to the rotation  
4        of said first rotation axis;

5                a second magnetic body that rotates according to the rotation  
6        of said second rotation axis;

7                a coil that generates a flux in a magnetic path including said  
8        first and second magnetic bodies;

9                a first magnetic sensing element that detects the flux which  
10       changes according to the rotation of said first rotation axis;

11               a second magnetic sensing element that detects a flux which  
12       changes according to the rotation of said second rotation axis;

13       and

14               first and second detection circuits that detect the rotation  
15       angle of said first and second rotation axes by using the output  
16       of said first and second magnetic sensing elements according to  
17       the change of flux.

1        **9.** An angle-torque sensor according to claim 8, further comprising:

2                a torsion bar that connects between said first and second  
3        rotation axes and is twisted by a torque generated between said  
4        first and second rotation; and

5                a torque detection circuit that detects said torque from a  
6        difference between the rotation angles detected by said first and

7 second detection circuits.

1 10. An angle sensor, comprising:

2 a rotation axis;

3 a magnetic body that rotates according to the rotation of said  
4 rotation axis;

5 a coil that generates a flux in a magnetic path including said  
6 magnetic body;

7 a plurality of magnetic sensing elements that detect the flux  
8 which changes according to the rotation of said rotation axis; and

9 a detection circuit that detects the rotation angle of said  
10 rotation axis by using the output of said magnetic sensing elements  
11 according to the change of flux;

12 wherein at least one of said plurality of magnetic sensing  
13 elements includes a mechanism that rotates being reduced or  
14 increased of its speed according to the rotation of said rotation  
15 axis.

1 11. An angle sensor, comprising:

2 a rotation axis;

3 a first magnetic body that rotates with said rotation axis;

4 a second magnetic body that rotates reducing or increasing  
5 the speed of said rotation axis;

6 a coil that generates a flux in a magnetic path formed by said  
7 first and second magnetic bodies;

8 a first magnetic sensing element that detects the flux which  
9 changes according to the rotation of said first magnetic sensing  
10 element;

11 a second magnetic sensing element that detects a flux which  
12 changes according to the rotation of said second magnetic sensing  
13 element; and

14 a detection circuit that detect the rotation angle of said  
15 rotation axis from a difference between the outputs of said first  
16 and second magnetic sensing elements according to the change of  
17 flux.

1 12. An angle-torque sensor, comprising:

2 a torque detection coil that detects a change in state  
3 quantity in a mechanism to detect a relative angle made between  
4 input axis and output axis of a torsion bar to be twisted by a torque;

5 an angle detection coil that detects a change in state  
6 quantity in a mechanism to detect a rotation angle of a reduction  
7 axis which rotates with a rotation being transmitted from said input  
8 axis or output axis and being reduced by a reduction mechanism;

9 a torque detection circuit that detects the relative angle  
10 from the output of said torque detection coil; and

11 an angle detection circuit that detects the rotation angle  
12 from the output of said angle detection coil.

1 13. The angle-torque sensor according to claim 12, wherein:

2 said reduction mechanism is a planetary gear unit including  
3 a sun gear, a planet gear and a ring gear.

1 14. The angle-torque sensor according to claim 12, wherein:

2 said reduction mechanism has a reduction ratio of 1/4 to 1/10.

1    **15.** The angle-torque sensor according to claim **12**, wherein:  
2           said torque detection coil and said angle detection coil have  
3 the same shape.

1    **16.** The angle-torque sensor according to claim **12**, further  
2 comprising:

3           a compensation means for compensating one or both of the  
4 output of said torque detection coil and the output of said angle  
5 detection coil.

1    **17.** The angle-torque sensor according to claim **12**, wherein:

2           said torque detection coil includes first and second  
3 detection coils,

4           said angle detection coil includes third and fourth detection  
5 coils,

6           said torque detection circuit detects the torque by detecting  
7 the relative angle from a difference between the outputs of said  
8 first and second detection coils,

9           said angle detection circuit detects the rotation angle from  
10 a difference between the outputs of said third and fourth detection  
11 coils, and

12          said first to fourth detection coils are disposed on the same  
13 axis.

1    **18.** The angle-torque sensor according to claim **16**, wherein:

2           said compensation means includes a compensation coil that  
3 detects a state quantity determined by a mechanism which gives a  
4 compensation signal to compensate the output of said torque

5 detection coil and said angle detection coil, and a compensation  
6 circuit that generates the compensating signal from the output of  
7 said compensation coil.

1 **19.** The angle-torque sensor according to claim **16**, wherein:

2 said torque detection coil includes first and second  
3 detection coils,

4 said torque detection circuit detects the torque from a  
5 difference between the outputs of said first and second detection  
6 coils, and

7 said compensation means is a compensation circuit that  
8 generates a compensation signal from an average of the outputs of  
9 said first and second detection coils to compensate the output of  
10 said angle detection coil.

1 **20.** The angle-torque sensor according to claim **18**, wherein:

2 said torque detection coil detects a change in inductance that  
3 changes according to a relative angle between a detection ring  
4 disposed on said input axis and a detection ring disposed on said  
5 output axis,

6 said compensation coil detects an inductance determined by  
7 a compensating ring being fixed and the detection ring of said input  
8 axis or said output axis, and

9 said angle detection coil detects a change in inductance that  
10 changes according to a relative angle between a reduction axis  
11 detection ring being disposed on said reduction axis and said  
12 compensation ring.

1     **21.** The angle-torque sensor according to claim **18**, wherein:

2             said torque detection coil detects a change in inductance that  
3     changes according to a relative angle between a detection ring  
4     disposed on said input axis and a detection ring disposed on said  
5     output axis,

6             said compensation coil detects an inductance determined by  
7     a compensating ring, and

8             said angle detection coil detects a change in inductance that  
9     changes according to a relative angle between a reduction axis  
10    detection ring being disposed on said reduction axis and a fixed  
11    ring..

1     **22.** The angle-torque sensor according to claim **19**, wherein:

2             said first and second detection coils detect a change in  
3     inductance that changes according to a relative angle between a  
4     detection ring disposed on said input axis and a detection ring  
5     disposed on said output axis, and

6             said angle detection coil detects a change in inductance that  
7     changes according to a relative angle between a reduction axis  
8     detection ring being disposed on said reduction axis and a fixed  
9     ring.

1     **23.** An angle-torque sensor, comprising:

2             first and second rotation axes that are connected to a torsion  
3     bar to be twisted by a torque;

4             a first magnetic body that rotates with said first rotation  
5     axis;

6             a second magnetic body that rotates with said second rotation



7 axis;

8 a torque detection coil that generates a flux in a magnetic  
9 path including said first and second magnetic bodies;

10 a torque detection circuit that detects the output voltage  
11 of said torque detection coil which changes according to a relative  
12 position between said first and second magnetic bodies;

13 a third magnetic body that rotates according to the rotation  
14 of said second rotation axis;

15 a compensation coil that generates a flux in a magnetic path  
16 including said second and third magnetic bodies;

17 a compensation circuit that corrects the output of said torque  
18 detection circuit by using the output voltage of said compensation  
19 coil;

20 a first magnetic sensing element that detects a flux which  
21 changes according to the rotation of said third magnetic body; and

22 a first angle detection part that detects the rotation angle  
23 of said third magnetic body from the output of said first magnetic  
24 sensing element according to the change in flux.

1 **24.** An angle-torque sensor according to claim **23**, further  
2 comprising:

3 a second magnetic sensing element that detects a flux of said  
4 compensation coil which changes according to the rotation of said  
5 second magnetic body; and

6 a second angle detection part that detects the rotation angle  
7 of said second rotation axis from the output of said second magnetic  
8 sensing element  
9

10   **25.** An angle-torque sensor, comprising:

11           first and second rotation axes that are connected to a torsion  
12 bar to be twisted by a torque;

13           a first magnetic body that rotates with said first rotation  
14 axis;

15           a nonmagnetic body that rotates with said second rotation  
16 axis;

17           a torque detection coil that generates a flux in a magnetic  
18 path formed by said first magnetic body and being shielded by said  
19 nonmagnetic body;

20           a torque detection circuit that detects the output voltage  
21 of said torque detection coil which changes according to a relative  
22 position between said first magnetic body and said nonmagnetic body;

23           a second magnetic body that rotates with said first or second  
24 rotation axis;

25           a compensation coil that generates a flux to said second  
26 magnetic body;

27           a compensation circuit that corrects the output of said torque  
28 detection circuit by using the output voltage of said compensation  
29 coil;

30           a magnetic sensing element that detects a flux of said second  
31 magnetic body which changes according to the rotation of said first  
32 or second magnetic body; and

33           an angle detection part that detects the rotation angle of  
34 said first or second magnetic body from the output of said magnetic  
35 sensing element according to the change in flux.

1   **26.** An electric power steering unit, comprising:

2 a motor that drives a steering rotation axis;

3 a steering sensor that includes: a torque detection coil that  
4 is disposed on said rotation axis and detects a change in state  
5 quantity in a mechanism to detect a steering angle from a relative  
6 angle made between input axis and output axis of a torsion bar to  
7 be twisted by the steering torque; an angle detection coil that  
8 detects a change in state quantity in a mechanism to detect a  
9 steering angle from a rotation being transmitted from said input  
10 axis or output axis and being reduced by a reduction mechanism;  
11 a torque detection circuit that detects the steering torque by  
12 detecting the relative angle from the output of said torque  
13 detection coil; and an angle detection circuit that detects the  
14 steering angle from the output of said angle detection coil; and  
15 a controller that controls said motor based on the steering  
16 torque and steering angle to be detected by said steering sensor.

1 **27.** The electric power steering unit according to claim **26**, wherein:

2 said steering sensor further includes a compensation means  
3 that compensates one or both of the output of said torque detection  
4 coil and the output of said angle detection coil.

1 **28.** The electric power steering unit according to claim **26**, wherein:

2 said torque detection coil includes first and second  
3 detection coils,

4 said angle detection coil includes third and fourth detection  
5 coils,

6 said torque detection circuit detects the steering torque by  
7 detecting the relative angle from a difference between the outputs

8 of said first and second detection coils,  
9 said angle detection circuit detects the steering angle from  
10 a difference between the outputs of said third and fourth detection  
11 coils, and  
12 said first to fourth detection coils are disposed on the same  
13 axis.

1 **29.** The electric power steering unit according to claim **27**, wherein:  
2 said compensation means includes a compensation coil that  
3 detects a state quantity determined by a mechanism which gives a  
4 compensation signal to compensate the output of said torque  
5 detection coil and said angle detection coil, and a compensation  
6 circuit that generates the compensating signal from the output of  
7 said compensation coil, and  
8 said controller controls said motor based on the steering  
9 torque and steering angle to be corrected by said compensation  
10 means.

1 **30.** The electric power steering unit according to claim **27**, wherein:  
2 said torque detection coil includes first and second  
3 detection coils,  
4 said torque detection circuit detects the steering torque  
5 from a difference between the outputs of said first and second  
6 detection coils,  
7 said compensation means is a compensation circuit that  
8 generates a compensation signal from an average of the outputs of  
9 said first and second detection coils to compensate the output of  
10 said angle detection coil, and

11           said controller controls said motor based on the steering  
12 torque and the steering angle to be corrected by said compensation  
13 means.

1   **31.** An electric power steering unit, comprising:

2           a steering sensor that includes: a first and second rotation  
3 axes that are connected to a torsion bar to be twisted by a steering  
4 torque; a first magnetic body that rotates with said first rotation  
5 axis; a second magnetic body that rotates with said second rotation  
6 axis; a torque detection coil that generates a flux in a magnetic  
7 path including said first and second magnetic bodies; a torque  
8 detection circuit that detects the output voltage of said torque  
9 detection coil which changes according to a relative position  
10 between said first and second magnetic bodies; a third magnetic  
11 body that rotates according to the rotation of said second rotation  
12 axis; a compensation coil that generates a flux in a magnetic path  
13 including said second and third magnetic bodies; a compensation  
14 circuit that corrects the output of said torque detection circuit  
15 by using the output voltage of said compensation coil; a first  
16 magnetic sensing element that detects a flux which changes according  
17 to the rotation of said third magnetic body; and a first angle  
18 detection part that detects the rotation angle of said third  
19 magnetic body from the output of said first magnetic sensing element  
20 according to the change in flux; and

21           a motor that drives a steering rotation axis;

22           wherein the torque of said motor is controlled by using said  
23 steering torque and steering angle detected by said steering sensor.